

CA313 Algorithms and Complexity

Class Test 4

Attempt **all** questions. All questions carry equal marks. You have **45 mins.** to attempt these questions.

Name:

Student Number:

Q 1.

(i) Describe the Traveling Salesman Problem (TSP).

(ii) Describe an exact algorithm to solve the TSP. What is its time complexity?

(iii) Describe how the nearest neighbour heuristic works for the TSP. What is the time complexity of this approximated algorithm?

(iv) The hill-climbing algorithm explores the search space by going from one solution to one of its neighbouring solutions. So what is the difference with the nearest neighbour heuristic?

Q 2.

(i) What is an NP-complete problem?

(ii) Give two possible (and usual) lines of attack for NP-complete problems.

(iii) Give **one** example of an NP-intermediate problem.

(iv) The undirected hamilton cycle problem (UHCP) can be reduced (in polynomial time) to the traveling salesman problem (TSP). Tell whether the following assertions are true or false:

- The TSP is the complementary problem of the UHCP.
- Solving the TSP is at least as hard as solving the UHCP.
- An instance of the UHCP can be transformed in polynomial time into an instance of the TSP.
- Let L be a problem reducible to the UHCP. L is not necessarily reducible to the TSP.

Q 3.

(i) Explain in your own words what an heuristic is.

(ii) Why does the hill climbing heuristic get stuck in local optima?

(iii) How might this problem be overcome (still using the hill climbing heuristic)?

(iv) How does the simulated annealing method cope with the problem of local optima?

Q 4.

(i) What is the space complexity of the following algorithm?

```
// note: x is an unsorted array
int findMin(int[] x) {
    int k = 0; int n = x.length;
    for (int i = 1; i < n; i++) {
        if (x[i] < x[k]) {
            k = i;
        }
    }
    return k;
}
```

(ii) Explain in your own words why $PSPACE = NPSPACE$.

(iii) Provide a diagram which makes clear the relationship between time and space, for the time complexity classes P, NP and co-NP, and the space complexity class PSPACE.

(iv) Justify with your own words **one** of the relationships involved in this diagram (*i.e.* the relationship between any 2 of P, NP, co-NP and PSPACE).